REMARKS/ARGUMENTS

This paper is submitted in response to the Office Action mailed June 19, 2006. Reconsideration is respectfully requested.

Claims 1-23 were examined. Claims 24-34 have been cancelled as being drawn to a non-elected invention in response to a restriction/election requirement. The cancellation of claims 24-34 is without prejudice to Applicant's right to re-file those in a divisional application. In response to the Office Action, claims 1-4, 7, 9-16, 19, and 21-23 have been amended, as discussed below. Claims 5, 6, 8, 17, 18, and 20 have been cancelled.

**Rejection under 35 U.S.C. §112**

Claims 11 and 23 were rejected under 35 U.S.C. §112, second paragraph, because they included trademarks or trade names as limitations. These claims have been amended to remove the references to trademarks and trade names, and therefore they are now in compliance with Section 112.

**Rejections under 35 U.S.C. §§102(b) and 103(a)**

Claims 1-4 were rejected under 35 U.S.C. §102(b) as being anticipated by Amiridis et al., WO/9943610. Claims 7-12, 19, and 21-23 were rejected under 35 U.S.C. §103(a) as unpatentable over Amiridis et al. in view of US 6,468,480 – Clawson et al. and US 5,525,322 – Willms. Claims 13-16 were rejected under 35 U.S.C. §103(a) as unpatentable over Amiridis et al. These rejections are respectfully traversed.

Claim 1, as amended, recites a shell and tube reactor module for hydrogen production comprising a reactor having a shell side, at least one palladium membrane tube as a tubular section, and a steam reforming catalyst in the shell side; and a catalyst combustion section having a noble metal catalyst dispersed on a supporting material and surrounding the steam reforming catalyst. By contrast, the shell and tube reactors disclosed in Amiridis et al. comprise either a metal alloy membrane tube 12 surrounding a bed of catalyst material 18, as described at page 4, lines 4-20, and as shown in Fig. 1; or a metal membrane tube 32 surrounded by a

bed of catalyst material 38, as described at page 5, lines 3-16, and as shown in Fig. 4. In fact, the catalyst bed used in the Amiridis et al. device is a steam reforming catalyst for lowering the activation energy of the steam reforming reaction, and there is no teaching or suggestion that this catalyst bed is made of a noble metal. Indeed, the only material mentioned for it is $Ni/SiO_2$ (p. 4, lines 17-18).

Thus, there is no teaching or suggestion in the Amiridis et al. reference of a reactor including both a palladium membrane tube and a separate catalytic combustion section having a noble metal catalyst dispersed on a supporting material and surrounding the steam reforming catalyst. Specifically, in Fig. 1, the noble metal tube 12 surrounds the steam-reforming catalyst bed 18, but there is no separate catalytic combustion section having a noble metal catalyst dispersed on a supporting material and surrounding the catalyst bed 18. In Fig. 4, the steam-reforming catalyst bed 38 surrounds the noble metal tubes 32, instead of the noble metal catalyst surrounding the bed, as now defined in claim 1.

Viewed another way, the catalyst material used in the Amiridis et al. device is a steam reforming catalyst for lowering the activation energy of the steam reforming reaction. By contrast, the incorporation of a catalyst combustion section having a noble metal catalyst dispersed on a supporting material and surrounding the steam reforming catalyst, as specifically recited in amended Claim 1, is a unique construction of the steam reforming reactor for smoothing the endothermic steam reforming reaction at a high reaction temperature. Although the Amiridis et al. reference discloses an electric heater for controlling the reaction temperature, the technical result achieved is not the same as that achieved in the claimed invention. Specifically, with the electric heater of Amiridis et al., it is difficult to provide sufficient heat flux for the endothermic steam reforming reaction when the reactor is scaled up for practical application. It also would not allow a proper heat transfer for conduction to the center of the endothermic reactor for good control of the reaction temperature within the reactor. It is well known that the proper heat transfer to this endothermic reaction is as critical as the catalytic activity of the steam reforming

catalyst converting the raw material to the hydrogen product. The electric heat mentioned in the Amiridis et al. reference must always be applied outside of the shell, since the external electrical energy must be supplied for generating the heat energy.

On the other hand, the catalyst combustion section, as defined in claim 1, is not only applicable for the scaled-up reactor, but it is also capable of being installed inside of the shell of the reactor, since the catalyst combustion section is only the noble metal catalyst dispersed on a supporting material. It is respectfully pointed out that the noble metal catalyst for the catalyst combustion section is totally different from the steam reaction catalyst of the cited reference, since the respective catalysts are used for two different purposes, the former being used for heating, and the latter being used for lowering the activation energy of the steam reforming reaction, respectively. In addition, the catalyst combustion section of the claimed invention is able to recycle the exhaust gases generated during the steam reforming process in order to prevent the release of the incomplete reaction gases.

Accordingly, it is respectfully submitted that the technical features recited in amended Claim 1 are not only distinct from the device disclosed in the Amiridis et al. reference, but also offer advantages not contemplated by the art of record. Therefore, Applicant respectfully submits that claim 1, as amended, defines patentably over the Amiridis et al. reference, taken by itself or in combination with the other art of record, and should therefore be allowed. Claims 2-4, 7, and 9-12 depend from claim 1, and likewise define patentably over the art of record, taken singly or in any combination that may fairly suggest itself to those skilled in the pertinent arts. Accordingly, these claims should be allowed along with claim 1

Regarding amended claim 13, the technical features recited therein substantially correspond to those recited in amended Claim 1, except that the reactor is split into two reactor sections. Claim 13, as amended, is therefore respectfully submitted to be patentable over the art of record, for the reasons set forth above with respect to amended claim 1. Furthermore, neither of the secondary references

teaches how thermal energy is transmitted to the endothermic reaction, nor do these references teach the arrangement of the heating device. Accordingly, the Applicant respectfully submits that claim 13, as amended, can be neither anticipated nor rendered obvious by the cited references or any combination thereof that may fairly suggest itself to those skilled in the pertinent arts, nor can the advantageous features of the catalyst combustion section of the present invention, as defined in amended claim 13, be achieved thereby. Therefore, it is respectfully submitted that claim 13, as amended, defines patentably over the art of record and should be allowed.

Claims 14-16, 19, and 21-23 depend from claim 13, and likewise define patentably over the art of record, taken singly or in any combination that may fairly suggest itself to those skilled in the pertinent arts. Therefore, these claims should be allowed along with claim 13.

In summary, it is respectfully submitted that claims 1-4, 7, 9-16, 19, and 21-23, as amended, define patentably over the art of record and should be allowed. Passage of the application to issue is therefore earnestly solicited.

Respectfully submitted,

Date: September 19, 2006

HOWARD J. KLEIN
Registration No. 28,727

Klein, O'Neill & Singh, LLP (Customer No.: 22145)
43 Corporate Park, Suite 204
Irvine, California 92606
Tel: (949) 955-1920
Fax: (949) 955 1921
E-mail: hjklein@koslaw.com
Attorney Docket No. 586-31-PA